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Design, implementation and performance of an ecosystem monitoring program in Biosphere Reserves – the long-term observation of ecosystems in the Biosphere Reserves in the federal state Brandenburg (ÖUB)

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Abstract

Since 1999 a monitoring program (ÖUB) is performed within three Biosphere Reserves (BR) in Brandenburg, Germany. The design aims at the main ecosystems, and includes water, soil, flora and fauna. The value of this long term observation is demonstrated by example. The development of plant species richness in agricultural systems with different land-use practices in the BR Schorfheide-Chorin is shown. Furthermore, the documentation of changes in vegetation caused by elevation of groundwater tables in the BR Spreewald is presented.

Keywords

ecological assessment, long-term research, management support

Introduction

The MAB committee of UNESCO describes the implementation of ecological monitoring as one task of Biosphere Reserves (BR), adding to their protection and sustainable development functions. This monitoring is part of the integrated research and monitoring tasks of these protections areas (BFN 2008). The main aim of the ecological long-term observation is to record, trace and assess the ongoing development of typical ecosystems without direct human impact as well as ecosystems shaped by human land use in Biosphere Reserves (LUTHARDT 2010). In Germany the focus of monitoring activities at the Biosphere Reserves is set by the federal states in regard to their environmental and administrational framework.

At the late 1990s, the Brandenburg federal environmental agency installed a large all-embracing ecosystem monitoring program for its three Biosphere Reserves (Fig.1). It is focused on topical scale, as has been specified at the Sevilla-Strategy of UNESCO (1996). The program called ÖUB includes an observation of all ecosystem-compartments such as soil, water, vegetation and fauna (LUGV 2015). The main aims of the program are presented in Table 1. The monitoring is continuously executed since 1999 at the Biosphere Reserves Schorfheide-Chorin (BR SC) and Spreewald (BR SW). In the Biosphere Reserve Flusslandschaft Elbe (BR FE) it is conducted since 2003. The funding is carried out by the Brandenburg federal environmental agency. The leadership and administration are handled at the Eberswalde University for Sustainable Development (HNEE).

I	Documentation of the ecosystem development
II	Conclusions of the assessment of areas under the viewpoint of nature conservation
III	Basic knowledge for the control of the success of management measures
IV	Formulation of new strategies for the future use and management of ecosystems
V	Validation and Qualification of ecological Modelling
VI	Support for decision – making in nature conservation
VII	Public relations work about the development of ecosystems and representation of regional trends
VIII	Support for international duty to report within the framework of MAB-Network / continuous regional environmental reporting

Table 1: Main aims of the ecological long-term observation in the Biosphere Reserves in Brandenburg ÖUB (ÖUB 2017)

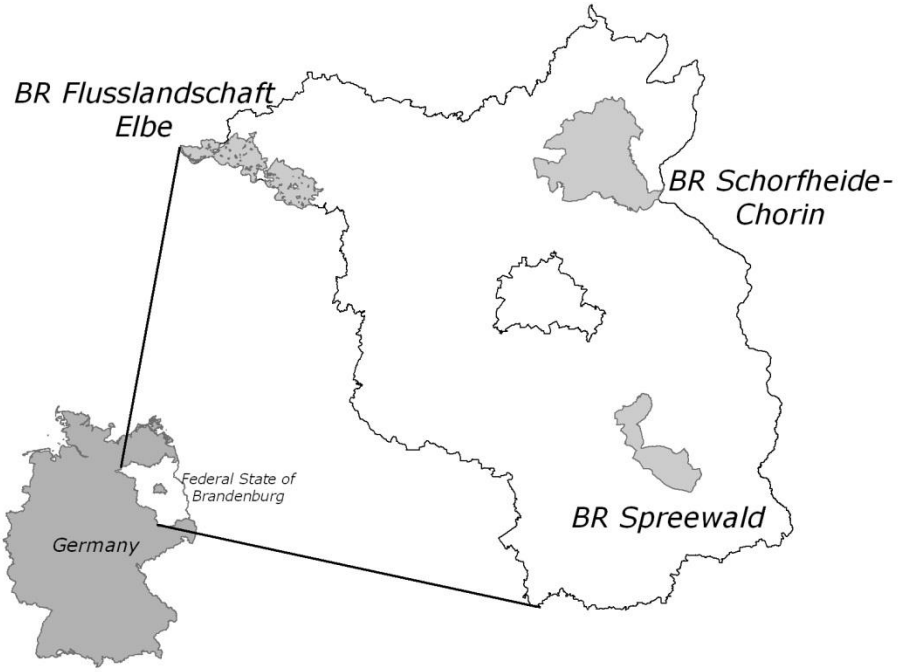

Figure 1: Localization of the three Biosphere Reserves in the land Brandenburg, Germany

Methods

The general steps to create a program for long-term observation are shown in Fig.2. At first the analysis of all different ecosystems (e.g. all types of forest ecosystems) in the BRs was conducted. These ecosystems were merged with existing types of land use (e.g. organic farming, conventional production) and in a work-sharing approach between all three BRs. Finally, 135 observation sites were chosen, each with specific combinations of ecosystem and land use (Tab.2). For further information see LUTHARDT et al. 2005 and VAHRSON et al. 2000.

Specific monitoring objectives were defined for each ecosystem category and standardized methods for handy measureable and interpretable parameters with high indicator levels were identified (LUTHARDT 2010; LUTHARDT et al. 2005). These methods and parameters are collected into a catalogue (LUTHARDT et al. 2006, ÖUB 2017). The measurements for the most parameters are repeated in a time interval of 3 years. A Microsoft Access-database was developed for archiving and data-mining.

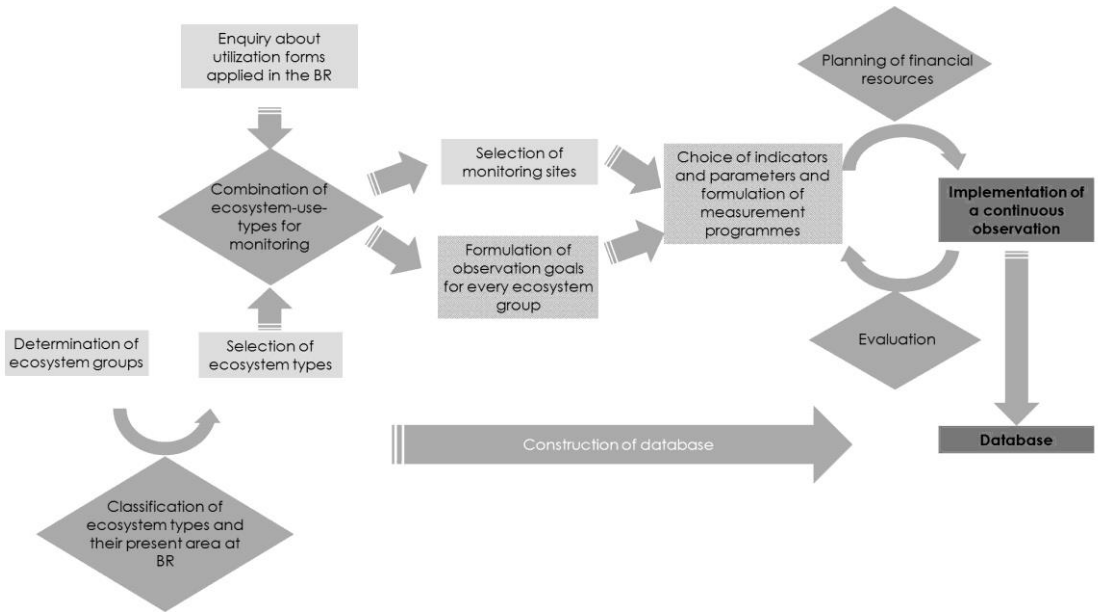

Figure 2: General steps to create the program for the long-term observation in the Biosphere Reserves of Brandenburg (LUTHARDT 2010)

Ecosystem Group	BR SC	BR SW	BR FE
Woodland / forest	22	8	8
Grassland on mineral soils	3	5	5
Grassland on peatlands	3	4	1
Arable land	5	2	-
Near-natural Fens	4	-	1
Lakes (* kettle holes,** back water)	30/4*	-	0/4**
Streams and ditches	-	13	13
Sum of observation sites	**71**	**32**	**32**

Table 2: Kind of ecosystem groups and number of monitoring areas of the ÖUB in the three biosphere reserves (BR) of Brandenburg – Schorfheide-Chorin (BR SC), Spreewald (BR SW), Flusslandschaft Elbe (BR FE)

Results

Up to 7 measurements are available per parameter collected with an interval of 3 years. Increasing knowledge of landscape development can be obtained with these datasets, according to land-use change as well as climate or water budget changes.

For example, different development between organic farmed and conventionally farmed land on areas with the same natural environment can be observed. With regard to their chemical soil properties no significant differences could be determined during the observation period. On the opposite, a significant difference in the population of arable wild species was documented. On organic farmed land a higher mean of plant species richness was determined compared to conventionally farmed land (Fig.3). Above all, arable wild species were more equally distributed on organic farmed land then on conventionally farmed land, where they are mainly on the edge of the site (BETHWELL et al. 2017). This is mostly referred to the application of herbicides. The documentation of rapid reclaim with species of sandy fallows and dry grassland on a sandy soil land during fallow is highlighted. Although, the permanent establishment of these plant communities depends on the further intensity of land use and abstinence of herbicides (BETHWELL et al. 2017).

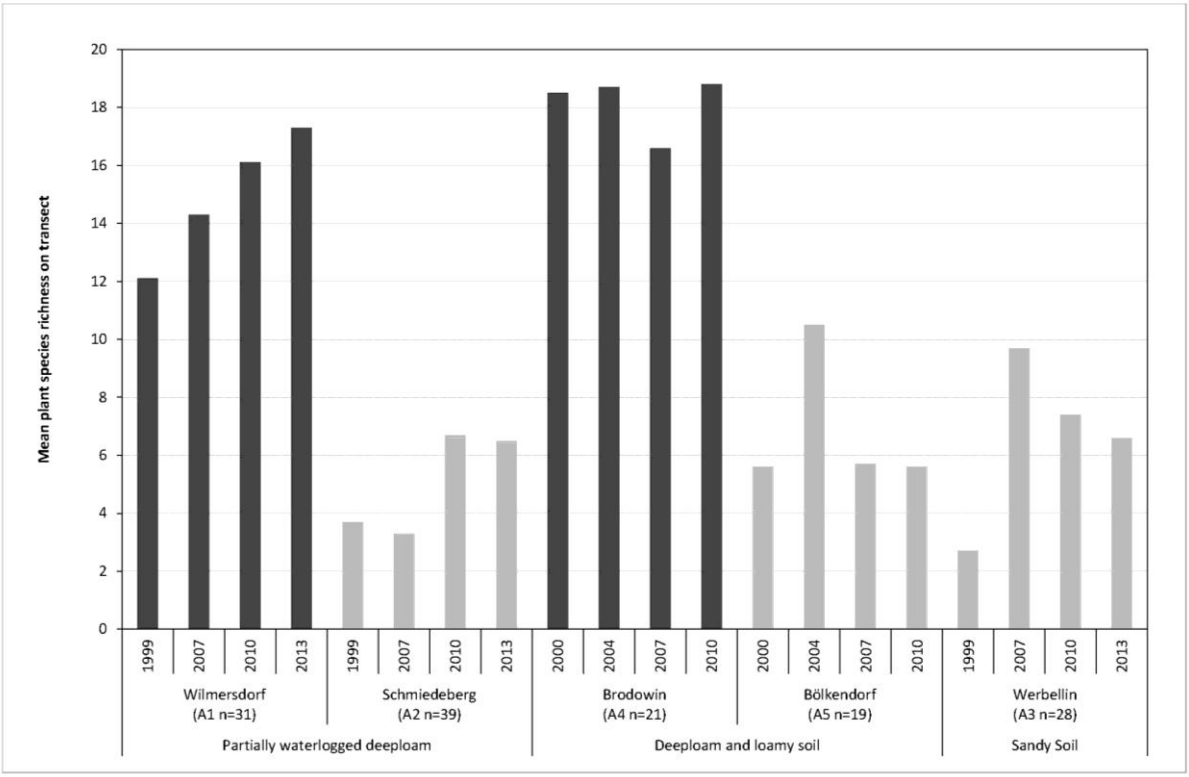

Figure 3: Wild plant species richness measured in a transect (average number of transect points with 6,3 m²) of organic farmed land (black) in comparison with conventionally farmed land (grey) (BETHWELL et al. 2017)

Another example for the increasing knowledge about ecosystem development in the last nearly two decades, which is observed by long-term observation, is the concrete documented change of vegetation and plant associations of grassland ecosystems in the BR Spreewald. Due to open-cast mining in the 20th century around the Spreewald region the groundwater table decreased on a large scale. With the political transformation in the early 1990s and the changes in production of energy, open-cast mining was fast reduced and the old sites were flooded. Therefore the groundwater table is now increasing continuously (LUGV 2015). This development and the influence of wet and dry weather periods over some years led to a change in vegetation at central 'Upper Spreewald'(Fig.4). During the observation period, plant species that indicate wet conditions displaced species indicating moderate humidity. Not only the vegetation was documented but also the changes in ground beetle and grasshopper populations (BETHWELL et al. 2017). With ongoing increase of the groundwater table, the objectives of the BR and of land-use management have to be reconsidered now to take care for the future (BETHWELL et al. 2017). The long-term observation can support these decisions by documenting and displaying the development.

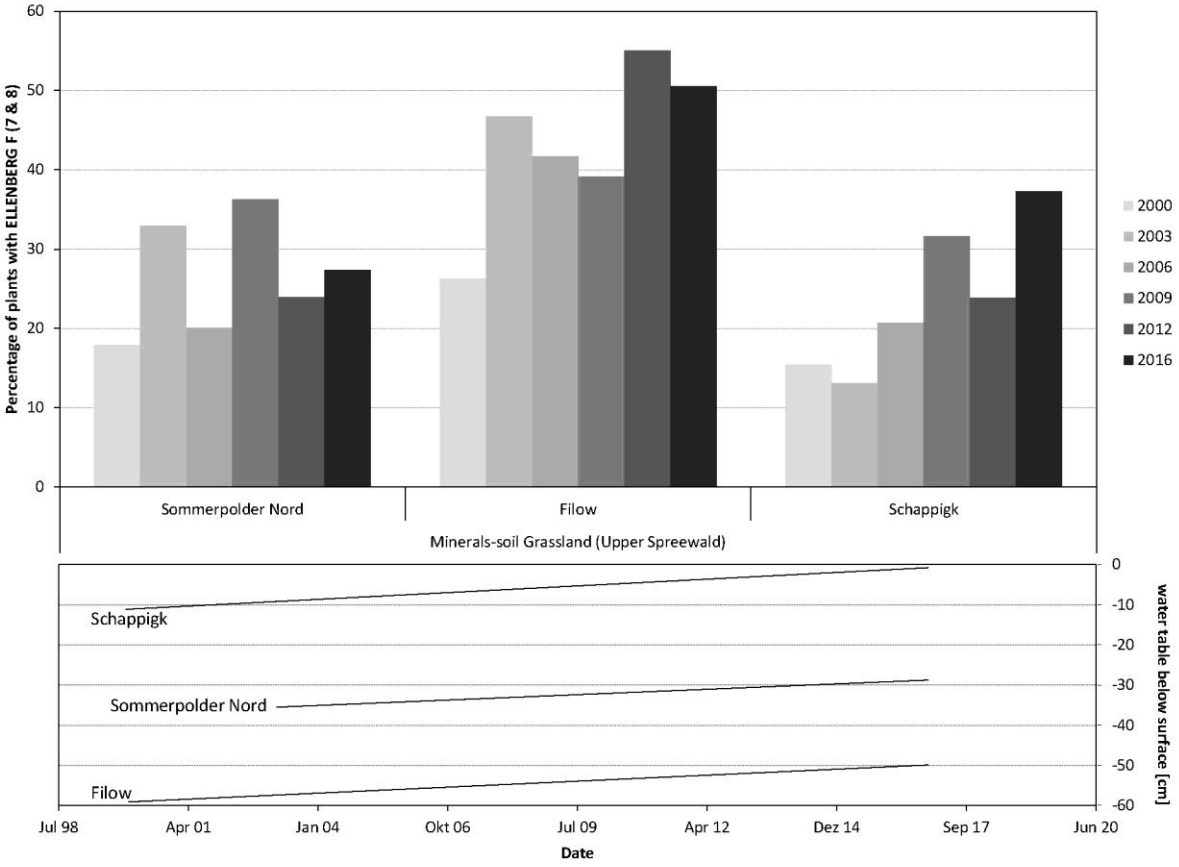

Figure 4: Percentage of plant species with an 'F-Zahl' according to ELLENBERG 7-8 (7 = wet, 8 = increasing wetness) and the course of the groundwater table in the last years at three observation sites of the ÖUB in the 'Upper Spreewald' in the BR Spreewald

Discussion

The monitoring program of the ÖUB was evaluated in 2015. All measurements were systematically analyzed and their value reviewed. Nearly all parameters were assessed as good in value as well as in measurement interval. The gaps pointed out should be closed in the close future. Priorities in monitoring objectives were switched for some ecosystem categories. The increasing value with duration was pointed out for the monitoring program ÖUB. The 135 observation sites are able to reveal a very satisfying impression of ongoing landscape developments, even though generalisations should be avaoided.

Conclusions

The ecological long-term observation of ecosystems in the Biosphere Reserves of Brandenburg provides information for the above shown main aims (Tab.1). The knowledge gained from this is very useful to support future management decisions to maintain and advance biodiversity in Biosphere Reserves. To achieve the optimal benefit, observations on topical scale have to be complemented with analyses on chorical scale to get a more accurate view on the complex landscape development. Similar to that, higher monitoring scales than the 'integrated monitoring' introduced by GEHRLEIN et al. (2014) are able to deal better with the complex requirements of decisions making in sustainable land-use. Observations on topical scale can support these monitoring approaches.

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